EPRI UPS Substation™

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Overview

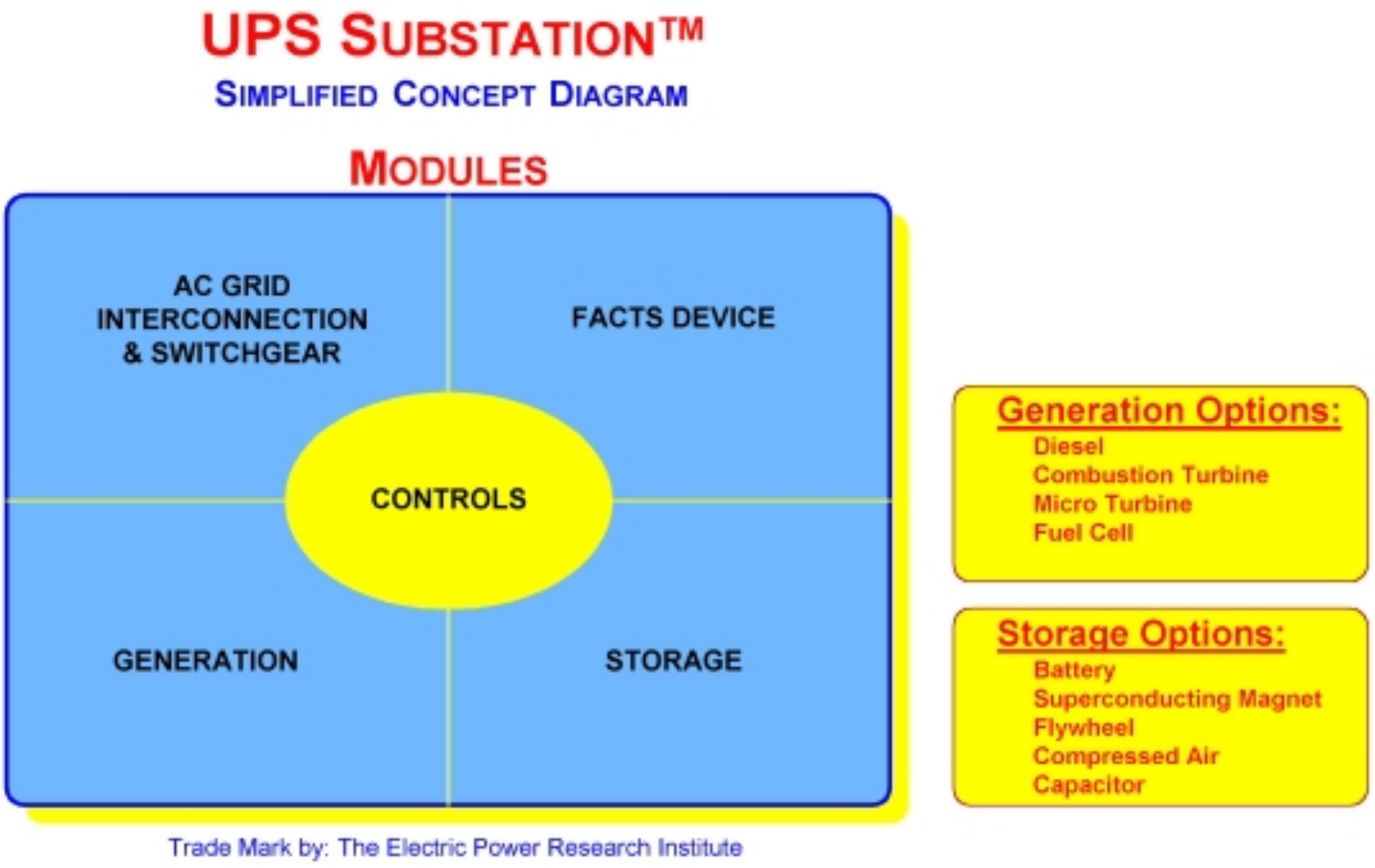
UPS Substation™

- What is UPS Substation and Why?
- Concept
- Application to Industrial PQ Problems
- Technology Status
- Prototype Demonstration

What Is UPS Substation™ ?

- Uninterruptible Power at Substation Level
  - Mitigate all disturbances (sub-cycle to hours)
  - Real & reactive power
- Modular, Customizable Power System
  - Select components to fit need
  - “Plug and Play” control system

UPS Substation™ System Concept



Trade Mark by: The Electric Power Research Institute

Why UPS Substation™ ?

UPS Substation™ is a Total Solution Technology that Provides:

- **Reliable Power … to sensitive loads served by dedicated substations**
- **Distributed Resources … in constrained T&D systems**
- **Voltage and Frequency Support … for T&D system stability**

Deteriorating PQ . . . Growing Financial Loss

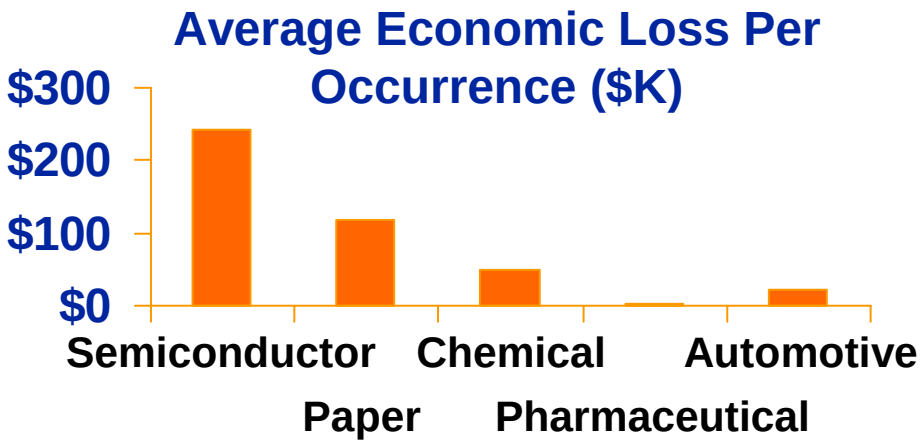
EPRI/Electrotek Study (1996):

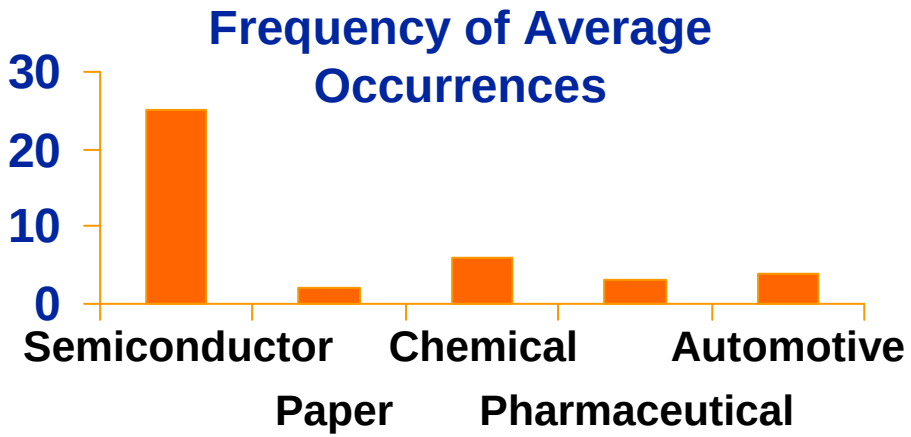
- Power quality problems are increasing.
- Problems are increasingly due to proliferation of sensitive and offending electronic industrial equipment.

EPRI Market Study (1999):

- Annual financial losses in 4 key industries exceeds $3.6 Billion
  - ✓Semiconductors → $1.6 Billion
  - ✓Automotive → $1.0 Billion
  - ✓Chemicals → $0.8 Billion
  - ✓Pharmaceuticals → $0.2 Billion

Business Impact of PQ Problems

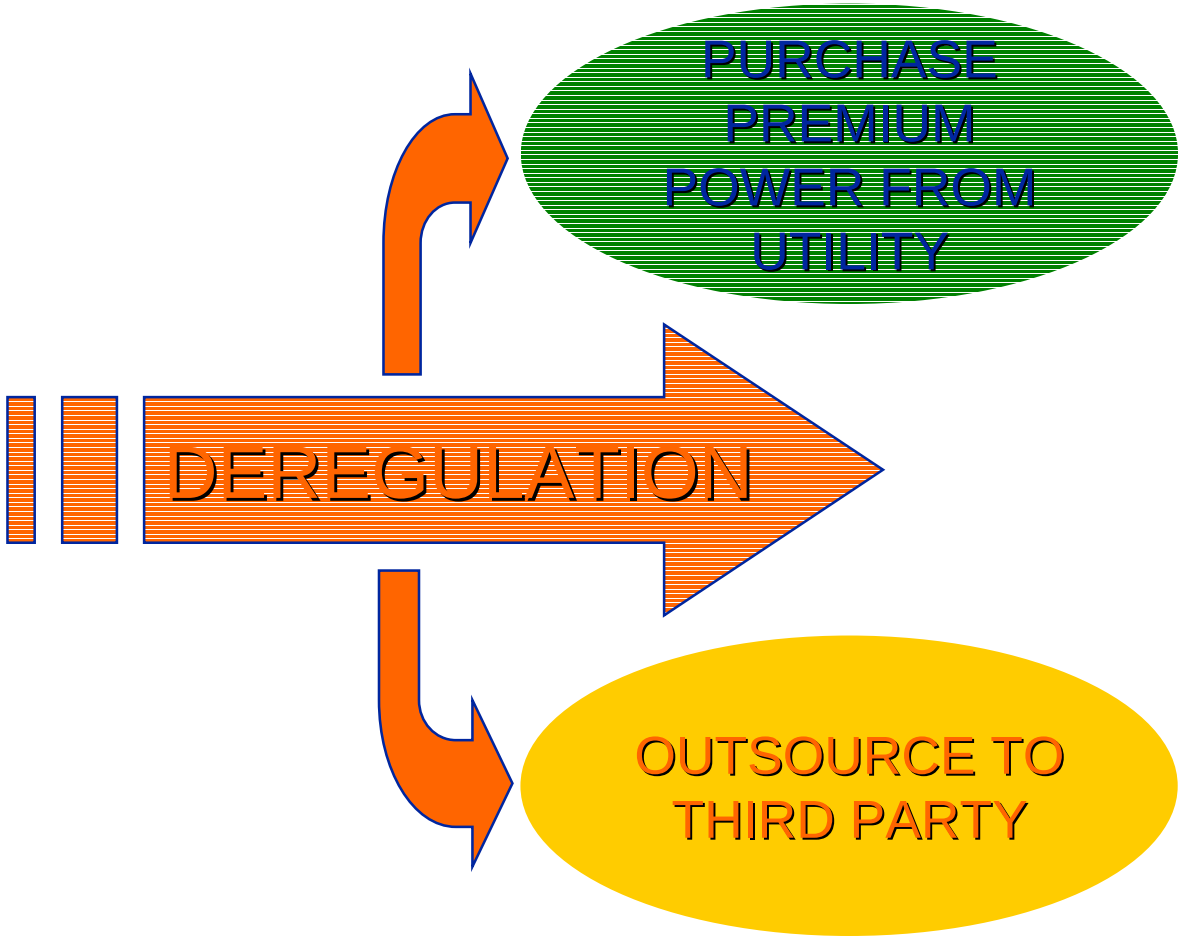




What Are the Customer's Options To Fix the Problem?

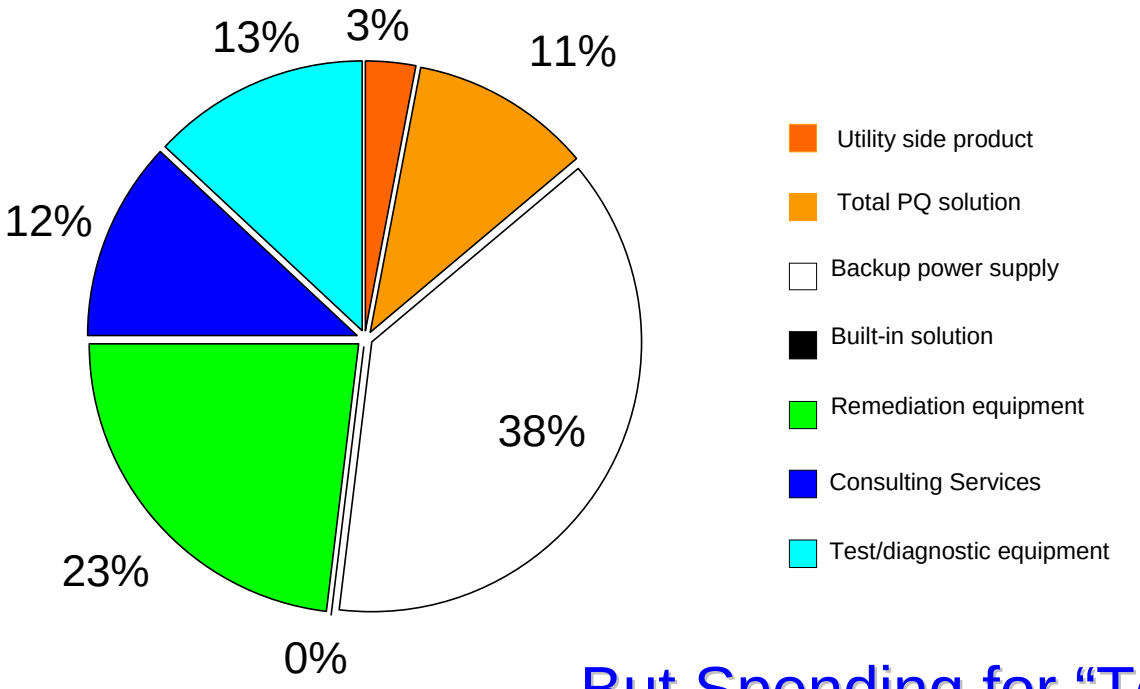
1999 Survey:

- **79% indicated desire to work with local utility to resolve PQ problems.**
- **35% indicated willingness to invest in a solution.**



Market Share for PQ Solution Type (by Actual Expenditures)

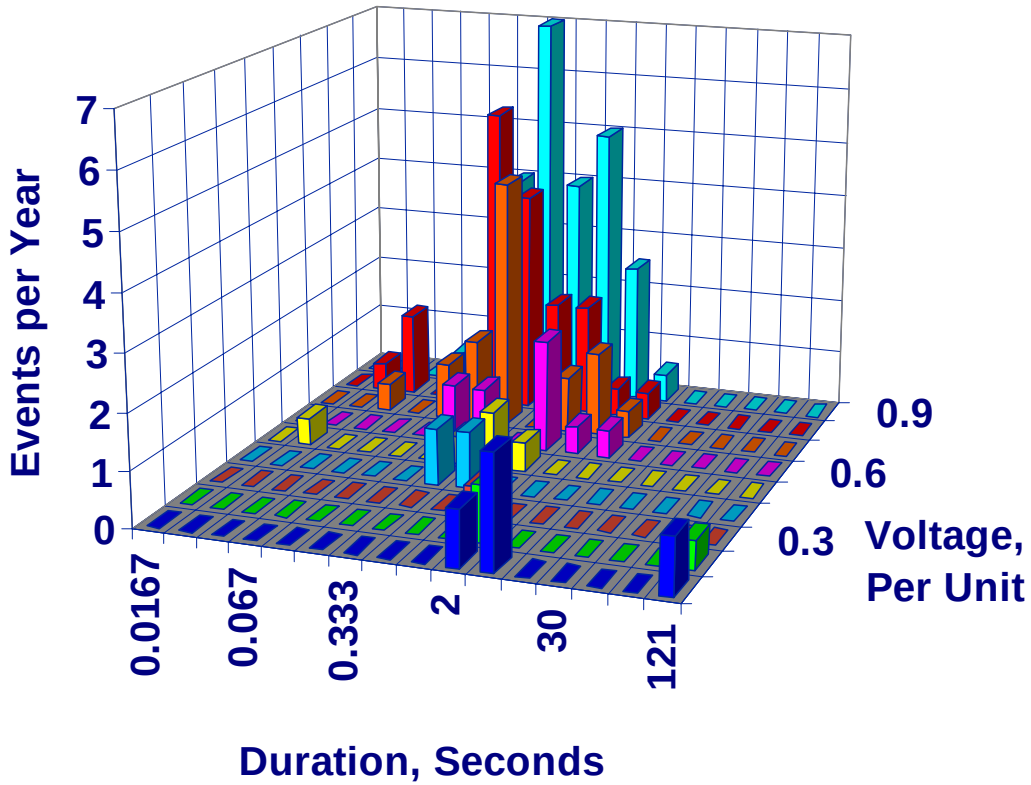
Total Industrial PQ Mitigation Spending Globally is ~ $1B ...



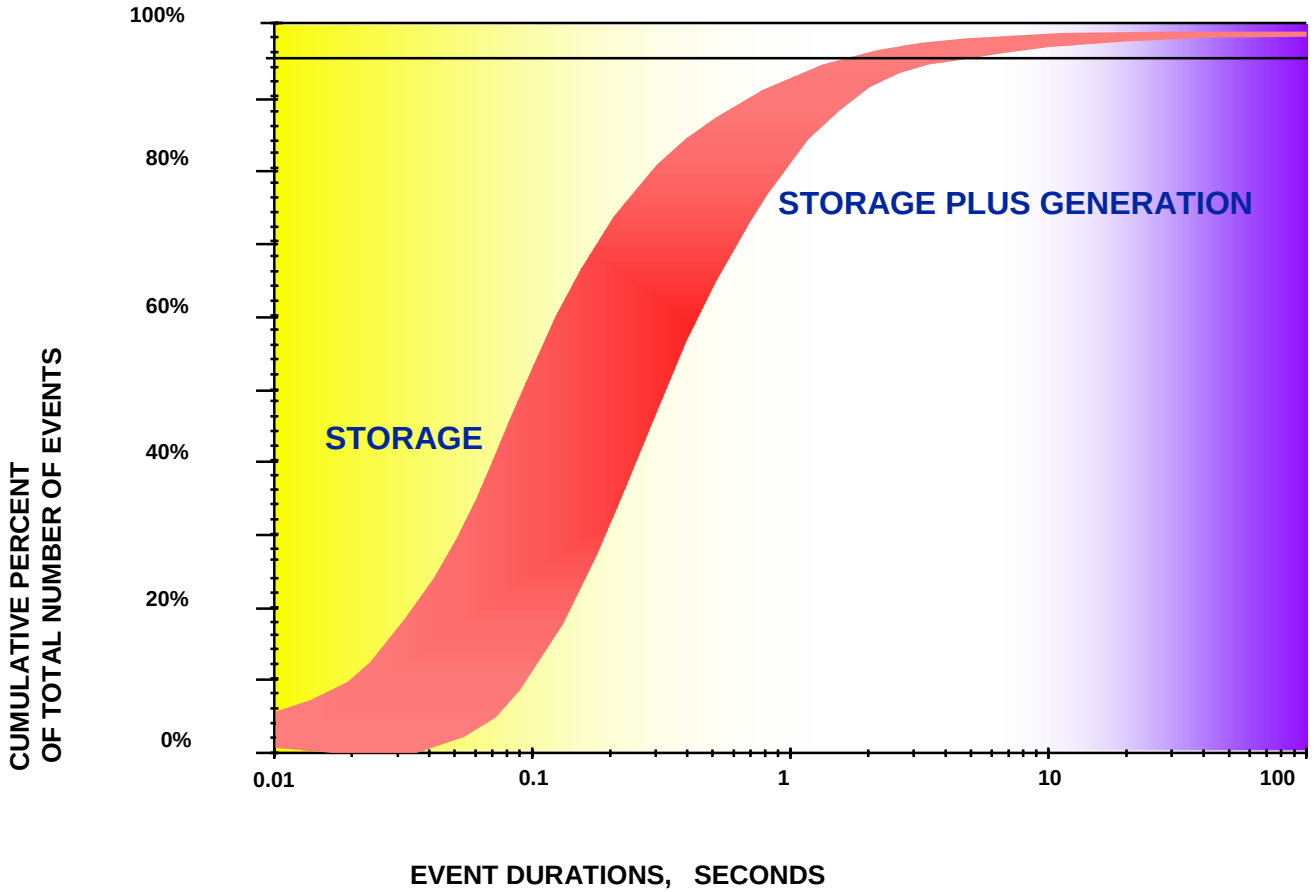
But Spending for "Total PQ Solution" is Expected to Quadruple to 46% by 2003

A Closer Look At the Problem ...

Most Events are a Few Seconds ...
-- but Some Last Much Longer

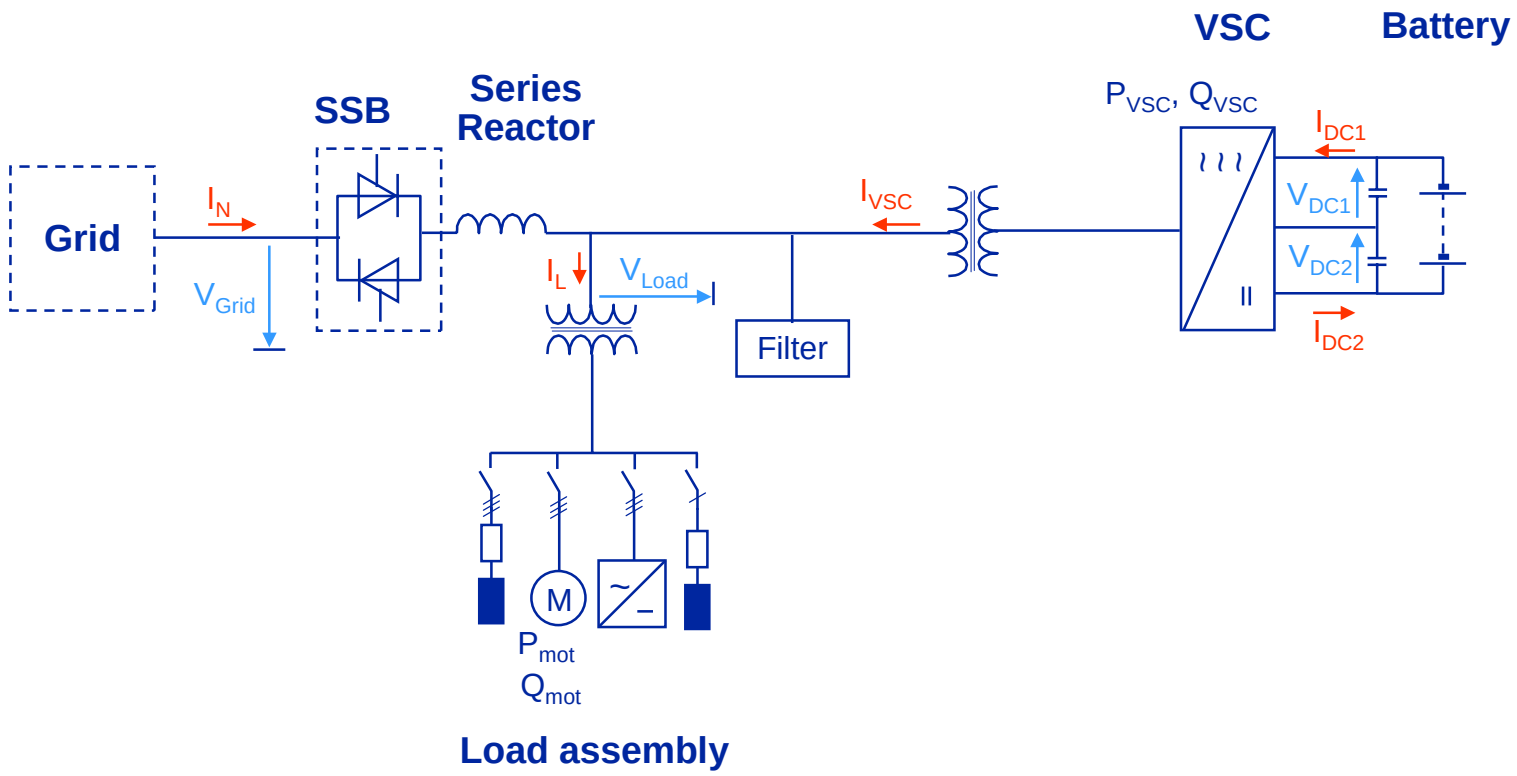


UPS Substation™ . . . A Tailored PQ Solution



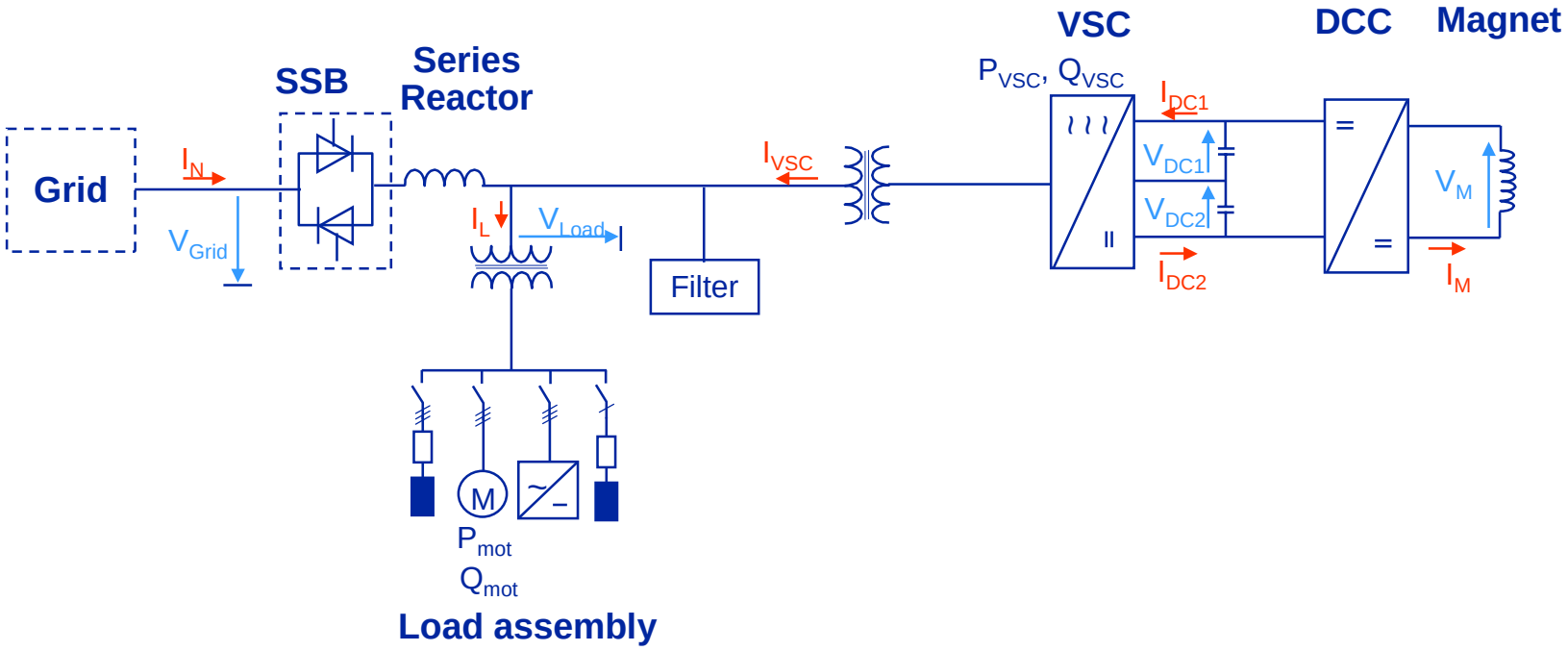
UPS Substation™ Typical System Diagrams

Configuration for Battery System



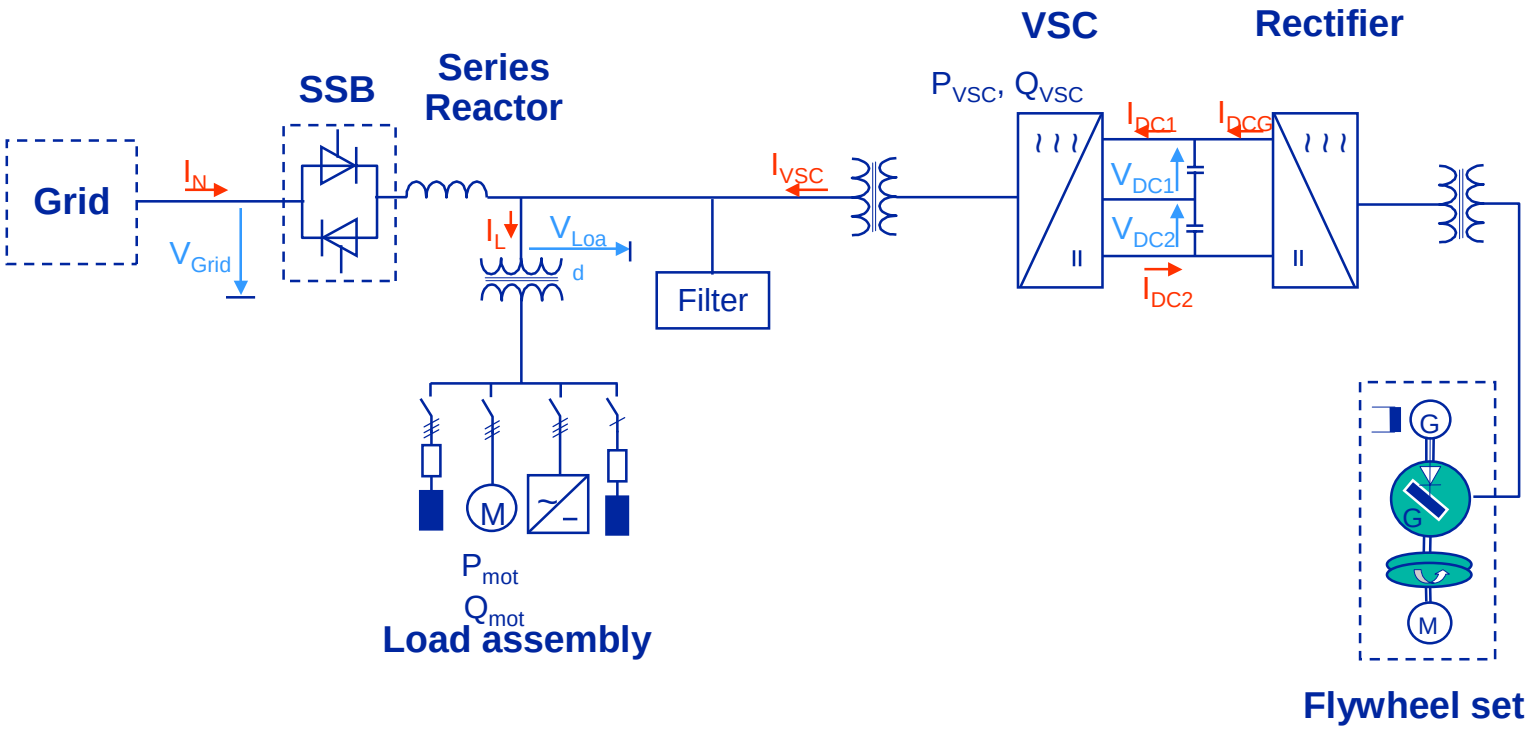
UPS Substation™ Typical System Diagrams

Configuration for SMES System



UPS Substation™ Typical System Diagrams

Configuration for Flywheel System



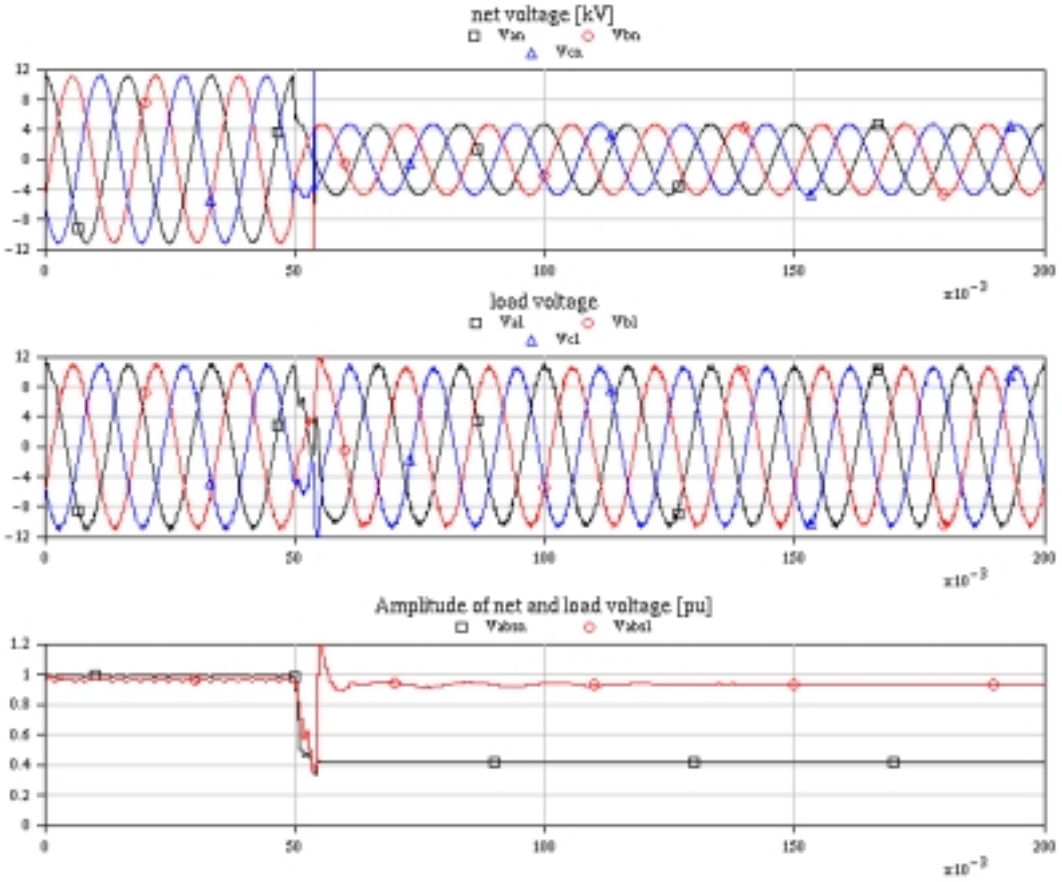
System Performance Simulations

Sample Result for Battery System (3-Phase, 60% Sag)

GRID VOLTAGE

LOAD VOLTAGE

AMPLITUDES



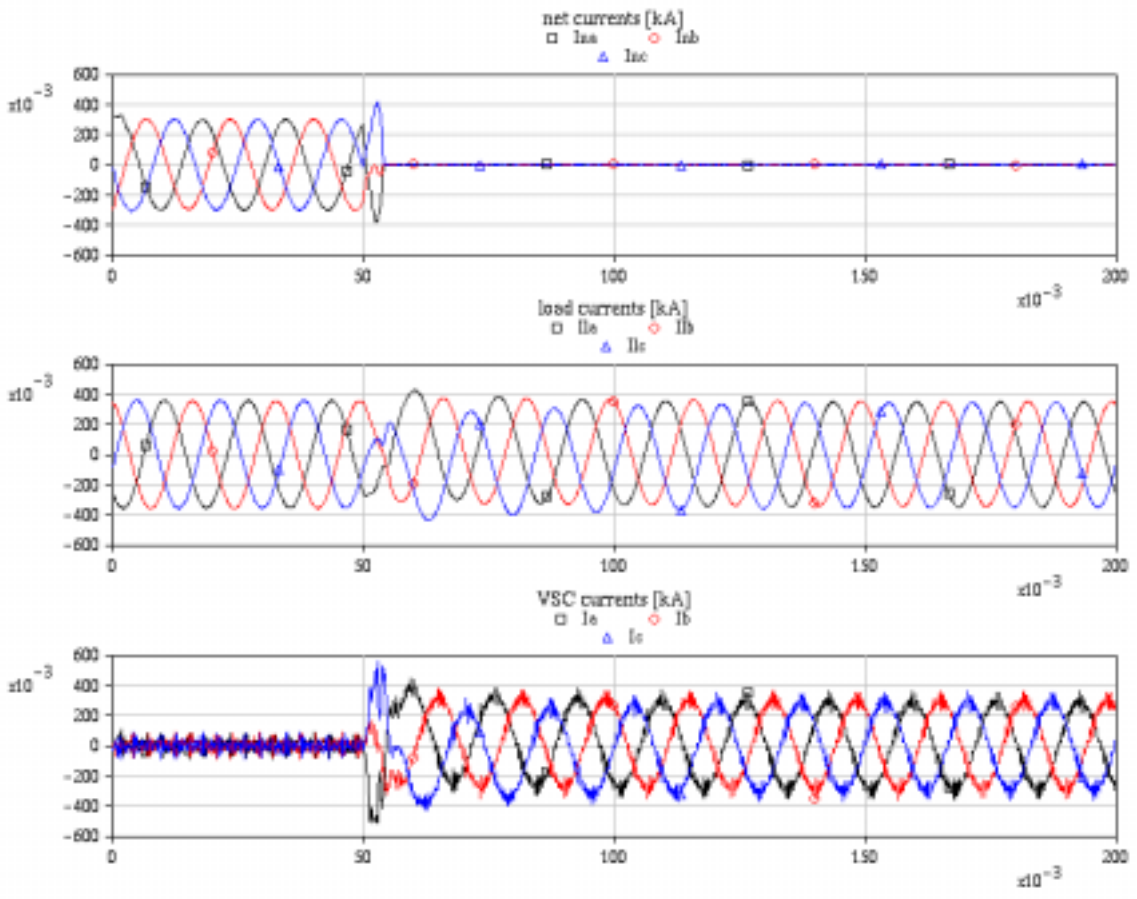
System Performance Simulations, Cont'd.

Sample Result for Battery System (3-Phase, 60% Sag)

GRID CURRENT

LOAD CURRENT

VSC CURRENT



UPS Substation™ . . . A Novel PQ Solution

Unique System Design:

- Instantaneous response w/o SSB operation for all sags down to ~ 60% (similar to DVR)
- Avoids “whip-sawing” the utility grid in shallow sag situations (superior to shunt UPS)
- Continuous load voltage control (VAR source)
- Maintains frequency stability during load takeover (superior to simple gen set)
- Excellent voltage and frequency response to load variations and faults

UPS Substation™ . . . A Reliable PQ Solution

Proven Hardware & System Approach:

- All major subsystems commercially available from multiple suppliers
- All major equipment currently in service worldwide in similar applications
- Turn-key system suppliers available to bid project

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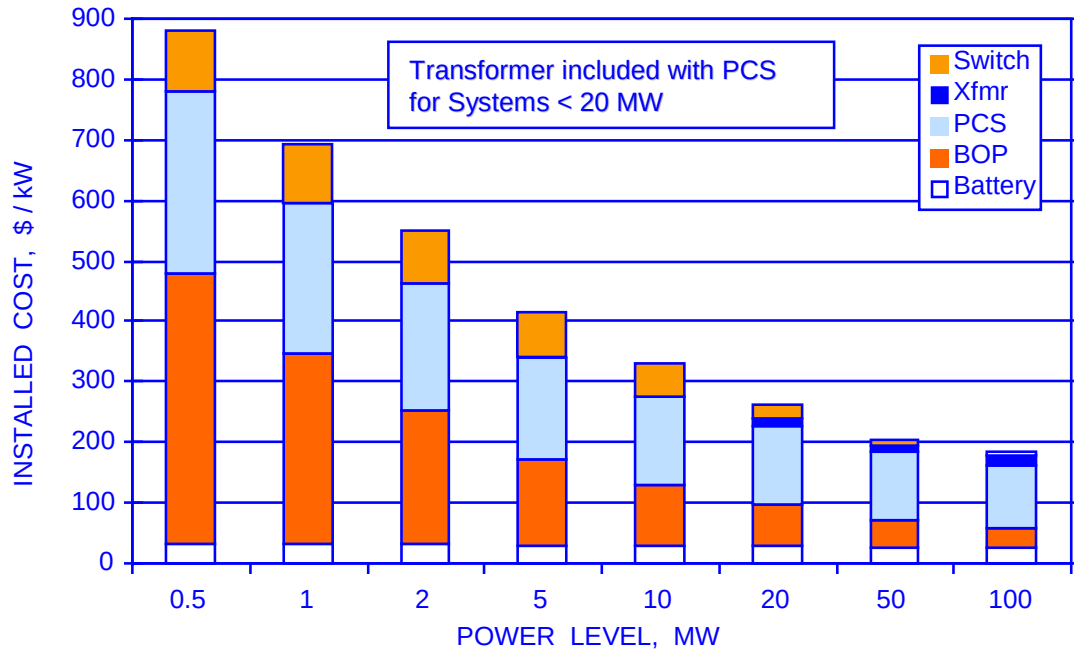
Estimated Costs, No Generation, Battery Storage



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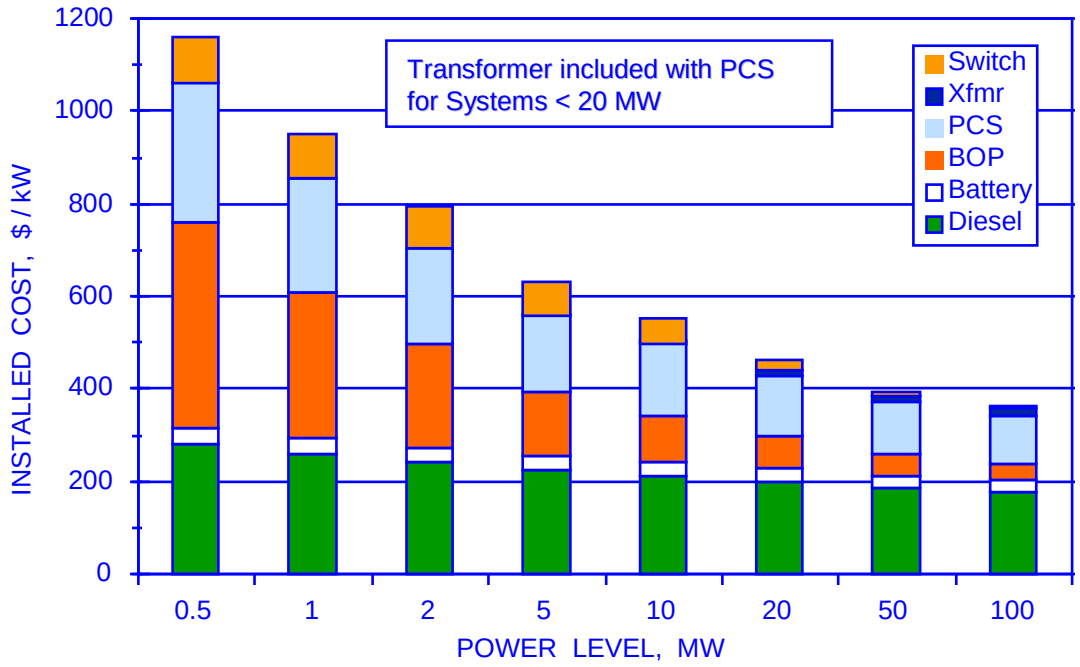
Estimated Costs, With Generation



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Status:

- Conceptual Study Complete (TR-111091, 10/99)
  - ✓ Conceptual Design Specifications
  - ✓ Preliminary Cost and Market Analysis
- Control System Design Underway
  - ✓ Feasibility Study Complete (1000002, 6/00)
  - ✓ Controller Specifications & Design Underway
- EPRI Soliciting a Host Demonstration Site

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Host Site Requirements:

- Attractiveness to Potential Near-Term Customers:
  - ✓ High Tech Manufacturing/Operations Load
  - ✓ PQ Problems at Site
  - ✓ Power Level 10 MW or More
- Customer Should Be Funding Partner
- "Ready Now" (Prototype Demonstration by 2002)